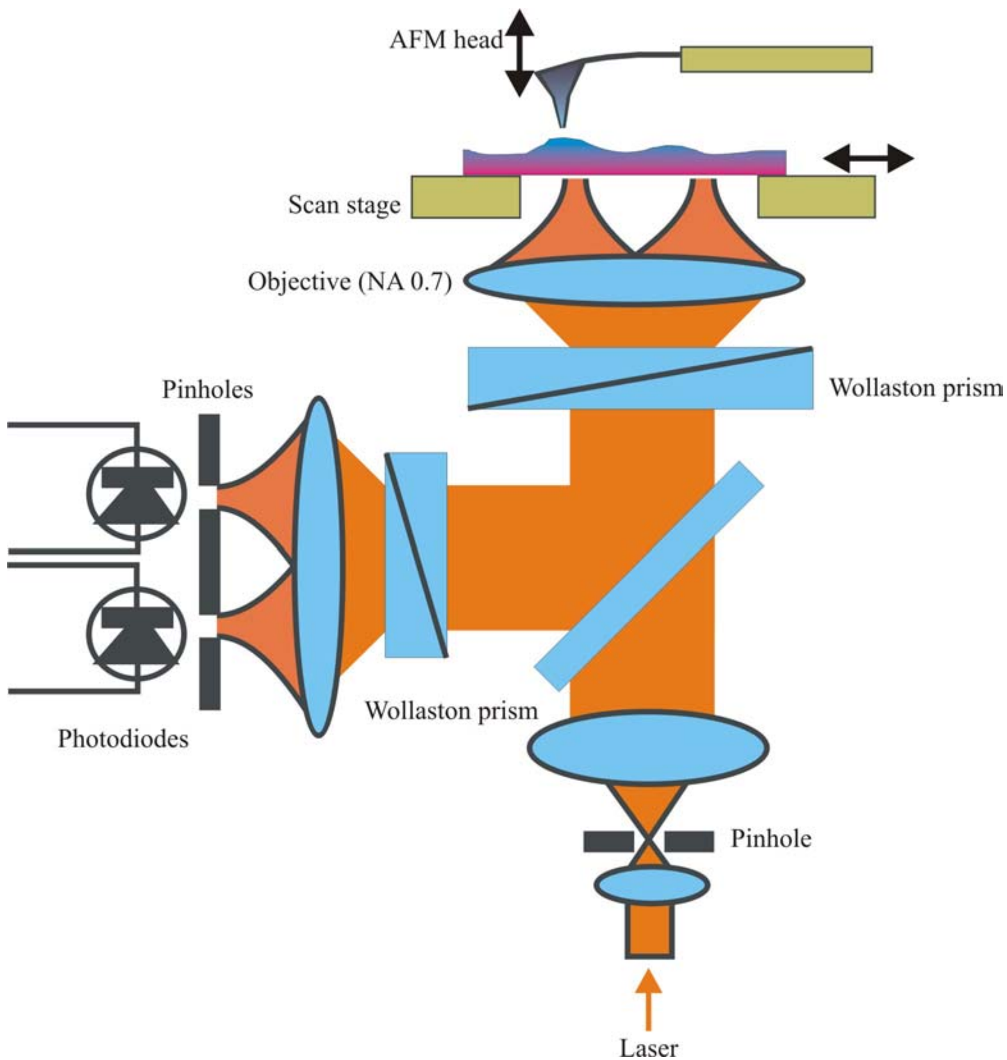
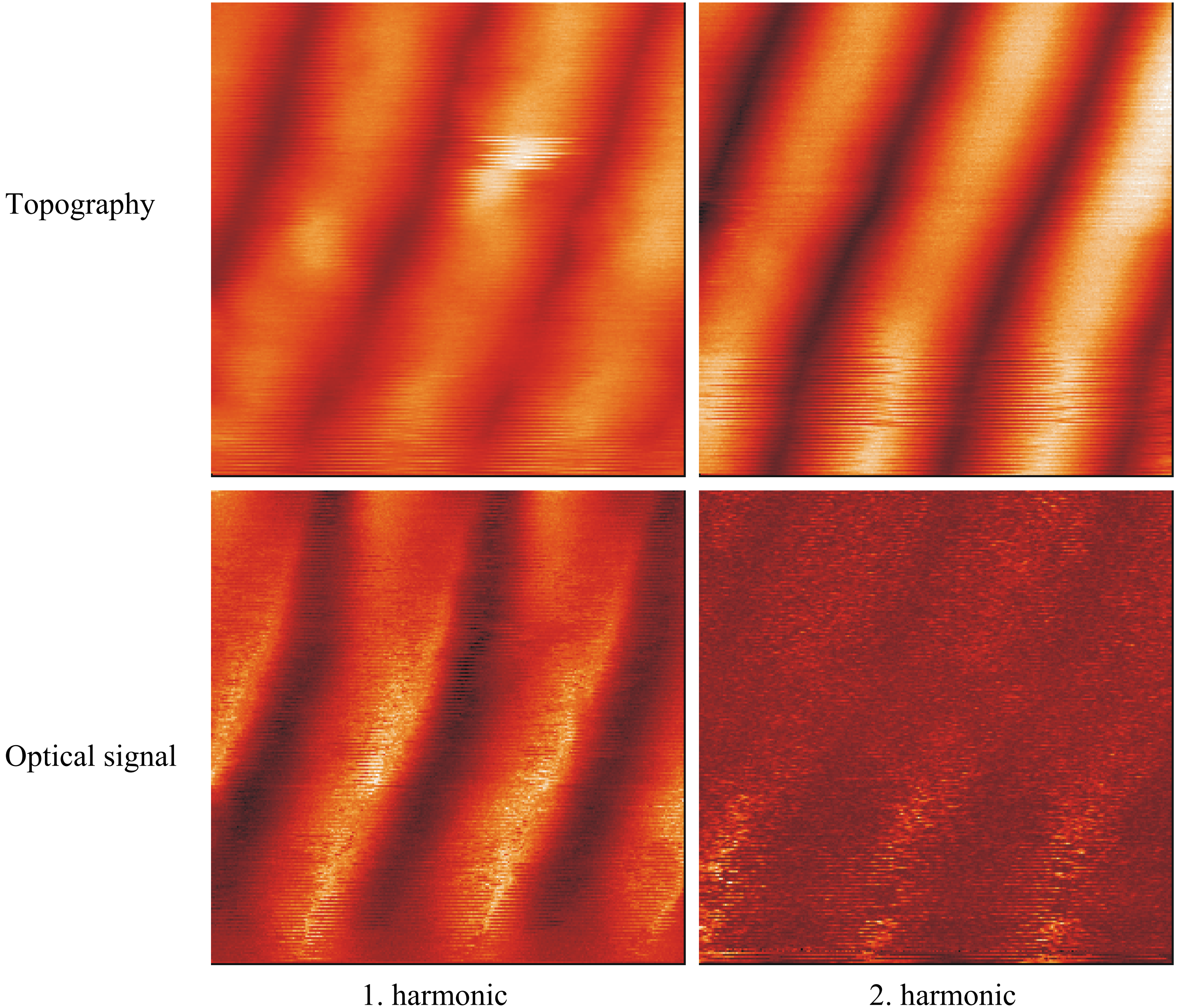

AFM head
Scan stage
Objective (NA 0.7)
Pinholes
Wollaston prism
Wollaston prism
Photodiodes
Pinhole
Laser

Leone is studying polymer photolithography with infrared near field optical microscopy. Polymer photoresist materials are tremendously important for the patterning of semiconductors, flat panel displays, and data storage device components. The rapidly decreasing line dimensions in these polymer photoresist materials, especially with the advent of deep-ultraviolet-exposed, chemically-amplified acid-catalyzed photoresist chemistry, places new demands on measurement characterization. In addition, this technology introduces important scientific problems, such as the need for studies of the rates of acid diffusion in polymers and the roughness of lithographic line features on nanometer length scales.

This project involves the development and use of the new method of infrared near field scanning optical microscopy (IR NSOM) to probe "spatially and chemically" the line dimensions patterned by deep-ultraviolet (UV) photochemistry in polymer photoresist materials. Experiments with IR NSOM in Leone's laboratory demonstrated that this method is remarkably powerful. Using tapered infrared transparent fiber optic tips and a 3 μm tunable color center laser, the project has demonstrated 300 nm spatial resolution ($\lambda/10$) and an absorption sensitivity of 0.01% transmittance, while probing the OH absorption band modifications in patterned poly(t-butylmethacrylate) PTBMA polymer containing 5 wt% of the photoacid generator (PAG) triphenylsulfonium hexafluoroantimonate deposited on sapphire substrates.

In the new work shown in several powerpoint images here, an apertureless near field optical microscope has been constructed and is now operational. The apertureless near field microscope has the advantage of much better spatial resolution, although it is more surface sensitive and subject to difficulties with topographic artifacts. The first images shown here are taken with visible light, and the signals arerecorded at the first and second harmonics of the modulation frequency. Those taken at the second harmonic should be free of topographic-induced artifacts. The first image is the overview schematic of the apertureless near field microscope apparatus. The second image is a scan of one of the photolithographic polymers studied in this project. The lines are somewhat distorted due to drifts in the sample-tip position. The third image is of a diblock co-polymer sample. The small dots are islands of one polymer in a sea of the other polymer. The contrast mechanism of the second harmonic signals in both cases is most likely due to variations in the index of refraction of the different polymer zones. The resolution is substantially improved in the optical images compared to typical tapered fiber near field experiments. The observed spatial resolution in the images is <50 nm.

Apertureless NSOM on photoresist (PTBOCST)
950 nm periodicity
3 μm x 3 μm scan



Apertureless NSOM on 2-block copolymer
polystyrol(1350)-b-poly(2-vinylpyridine)(400)
1 µm x 1 µm